

Olympic Region Environmental & Hydraulic Services Office

Guidance on Infiltration Design Rates

Infiltration is a desirable method of managing stormwater, and encouraged by the resource agencies and Tribes, because in many cases it slowly recharges the base flow of watercourses and provides water supply to streams during the summer low flow period that is critical for fish life. It is beneficial to WSDOT because it precludes downstream adverse impacts off the right of way. However, infiltration stormwater facilities require specific infiltration rates that are often difficult to find in native materials, and difficult to achieve from construction materials and techniques. This guidance letter addresses the challenge of determining and achieving adequate infiltration rates.

Generally, there are four situations we deal with regarding infiltration rates:

- 1) Wet Pond needed for water QUALITY control, and the design calls for an impervious bottom. For example, a wet pond is designed to work with a permanent pool of water which cannot be attained without an impervious layer. If the native material is not suitable for this type of a design (i.e., too porous), imported material (such as a clay liner) or a soil amendment can achieve the desired effect.
- 2) Infiltration Pond or Trench needed for water QUANTITY control only. A highly permeable soil condition is required. Infiltration rates in excess of six inches per hour would meet this description. If the native material possesses this characteristic, no problem. If not, options are generally limited. Over excavation and placement of more permeable materials is one option, but may only be appropriate if the impermeable layer is relatively thin. These facilities could be used to infiltrate all runoff, or a controlled outfall could be designed to meet the minimum quantity criteria only. Please note; some type of quality treatment is usually required prior to infiltration.
- 3) Infiltration Pond needed for water QUALITY control only. A soil condition is required that is not too porous or too tight, to allow the quality treatment to take place but still drain and prevent the pond from over-topping. The pond would be sized for the 6 month storm and would have a controlled outflow designed to pass the larger events. An infiltration rate range of $\frac{1}{2}$ to $2\frac{1}{2}$ inches per hour is required. If the native material has an infiltration rate in this range, no problem. If the native soil is too tight, soil amendments or over excavation and placement of more permeable materials is one option, but may only be appropriate if the impermeable layer is relatively thin. If the soil is too permeable, replacing or amending the soil may achieve the desired rates.

- 4) Infiltration Pond needed for water QUALITY and QUANTITY control. Soil is required that is porous enough to achieve quantity treatment, yet dense enough to slow infiltration to the point of providing quality treatment through plant uptake and prolonged contact with the soil. If the pond is sized to infiltrate all runoff, a controlled outfall is not necessary. This range has been defined for us in the Highway Runoff Manual (HRM) as ½ to 2½ inches per hour. As previously stated, soil amendments or over excavation and placement of more permeable materials are options, but may only be appropriate if the impermeable layer is relatively thin. If the soil is too permeable, replacing or amending the soil may achieve the desired rates.

WSDOT design staff generally uses three basic sources to determine infiltration rates:

- SCS (now NRCS) or other soil maps provide a range of values generally characteristic of the soil type native to the area. These maps are very useful in many ways, however, they cannot be relied upon to provide an infiltration rate accurate enough for design of stormwater infiltration/detention facilities.
- Gradation of soil samples taken from the area of the proposed stormwater facility, at the appropriate elevation. Results from this test are appropriate for design under certain circumstances. If the entire range produced by this test is clearly within the required parameters, it would be acceptable for design with the appropriate safety factor. For example, the test produced a range of 20 to 100 inches per hour, and failure of this facility would cause considerable damage. Considering these, and other factors, a design rate of 10 or 8 or even 6 inches per hour to size the pond may be appropriate.
- In-place infiltration tests. These should also be taken in the vicinity and at the elevation* of the proposed facility. Results from this test will generally yield a narrower range of rates than the other tests mentioned here. The results are usually appropriate for design if an applicable safety factor is applied.

*If the bottom of the proposed stormwater facility is more than four feet below the existing ground surface, in-place infiltration tests may be difficult and costly. Please contact Region Materials for additional information.

All of the above methods will not provide you with a design rate but a range of rates. To complicate matters, it is widely accepted that infiltration rates will fluctuate over time. This variability can be caused by many factors including plant growth, frequency of maintenance, volume of stormwater, ADT, pollution loading, etc. To verify how much confidence to put into an infiltration rate obtained from a particular source, or to request assistance, please contact the region Environmental & Hydraulic Services (EHS) Office.

Yet another variable is the safety factor. If infiltration occurs at a higher rate than predicted quality treatment and spill containment are degraded. If infiltration occurs at a slower rate than designed for, the stormwater facility may fail, cause property damage, and threaten public safety.

Input from maintenance on local conditions could be useful in corroborating the design infiltration rate determined by other methods. Also, the Region currently has on-call consultants who can determine infiltration rates.

From the discussion so far, it is obvious that the most difficult situation is either designing or verifying infiltration rates within the narrow range of ½ to 2½ inches per hour needed for a water quality infiltration facility. Considering the information presented in this letter, the Best Management Practice (BMP) choices outlined in the HRM, experimental BMPs, and current research being conducted by WSDOT and others, it is suggested all the data and resources available be considered prior to selecting a final design. The hydraulic unit of the EHS Office is available to assist in this process.

There are several steps the Olympic Region and OSC are currently taking to help this situation:

- Olympia Service Center (OSC) Materials Laboratory, Geotechnical Branch, has obtained an infiltrometer and has made it available for our use. (It is not ASTM certified, but is still useful).
- Region Materials is working to obtain a ASTM certified infiltrometer.
- The Region is currently developing research in conjunction with the US Geological Survey and OSC to produce a method of obtaining the desired infiltration rates using readily available construction materials.
- OSC is trying to obtain additional research funding for next biennium, in addition to current efforts.
- OSC and the Region have representatives on the committees currently re-writing the Department of Ecology stormwater manual. Our effort will include trying to get a wider range of infiltration rates for design purposes.

In conclusion, keep in mind that design infiltration rates are difficult to verify with any accuracy. Therefore, in most cases, using only one source (especially the SCS soil maps) to determine the design rate is not acceptable. There are several resources that can be used to help determine design infiltration rates, and designers cannot be expected know all strengths and shortcomings of each method. It is therefore imperative that the EHS Office be contacted early in the design process when an infiltration BMP is being considered.

The urgency of developing a more reliable method of determining design infiltration rates is being felt throughout the DOT, as evidenced by all the research and attention being given to this subject as of late. With this in mind, it is reasonable to expect this guidance to be updated often in the upcoming months.

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